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Distributional Features of Naiades in Tributaries of Lake Erie.

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The Naiad-fauna of Lake Erie is a glacial-postglacial offshoot of the Mississippi-Ohio-fauna, which has come chiefly by way of the Wabash-Maumee-route. This has been pointed out repeatedly (Ortmann, '12 p. 146; Walker, '13 p. 18, 58.) Some of the species are fully identical, but in other cases, Lake Erie proper contains more or less different forms, which, however, clearly take the place of the Ohio-types.

But one striking additional fact has been observed. The species of the Ohio, represented in the lake by different forms, generally present, in the tributaries of the lake, the common Ohio-phase, although this is not always the case. This fact has been commented upon by Walker ('13 p. 19), but he used it only in connection with the demonstration, that there are no pre-glacial relics in the lake basin. The present writer ('19) has pointed out several such cases*, and also Grier ('19 p. 163, 164) incidentally mentions this fact, although he does not take up this question in detail.

Several explanations have been suggested. (1) The one, that the types of shells of the lake tributaries identical with Ohio-types, are pre-glacial, has been finally disposed of by Walker. (2) Another suggestion is, that these forms, chiefly those of the southern tributaries of the lake, might have crossed over the divide from the tributaries of the upper Ohio (by stream-piracy or modern canals.) This has been hinted at by myself, ('19 p. 103),

* *Fusconaia flava*, p. 25; *Amblema costata*, p. 33; *Elliptio dilatatus*, p. 103; *Lasmigona costata*, p. 132; *Ligumia recta latissima*, p. 279; *Lampsilis siliquoidea*, p. 291; *Lampsilis ovata ventricosa*, p. 306.

but I was unable to find positive evidence for it. As will be shown below, this possibility *is positively excluded in certain cases, and surely does not apply in the case of northern and western tributaries of the lake.* (3) A third assumption is, that these forms, having reached the lake by the Maumee route, and having changed in the lake, ascended then from the lake into the tributaries, and assumed again the identical characters which they had, when living in the upper Ohio. This idea has been indicated by myself ('19 p. 25, 33, 132), but it is hard to imagine, that in every tributary, into which one of these lake forms went, it always returned precisely to the ancestral Ohio form. Below we shall become acquainted with at least two cases, where *this assumption is positively excluded,* because the forms concerned are not at all found in the lake.

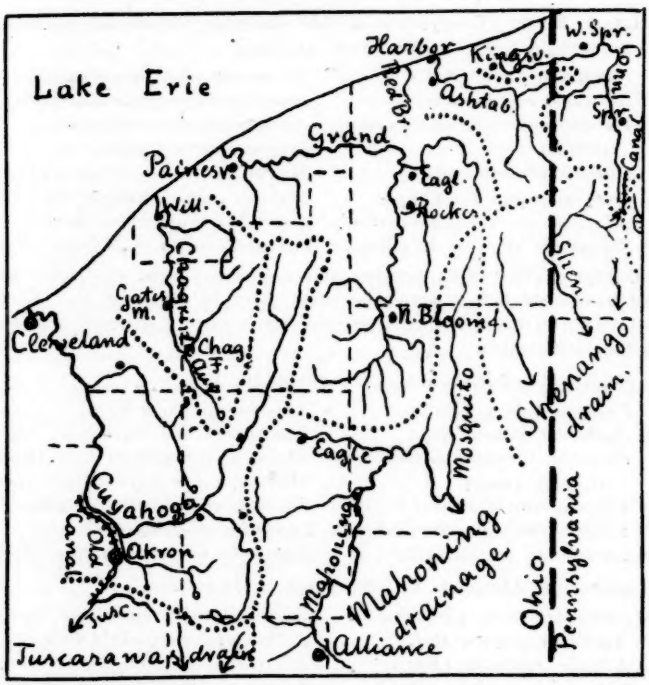
Thus there are objections to the assumption that any one of the above explanations is to be regarded as a *general* distributional law, and we are to look for another theory to which all of these cases might submit. And indeed, there is one, which has never been advanced. It is suggested by the *geological history* of the Lake Erie basin, and the present paper is written with the purpose to show, that there is another explanation, which *in several cases is the only possible one,* but which also can be applied very naturally to all other cases, although in some of them also the second idea, mentioned above, (crossing of the divide from the South) might be introduced as an additional possibility.

The new explanation entered my mind, when I explored certain tributaries of Lake Erie in northeastern Ohio and northwestern Pennsylvania, the basins of Chagrin River, Grand River, and Conneaut Creek (no Naiades were found in Ashtabula River.) Chiefly Grand River proved to be interesting for several reasons: it possesses a rather rich fauna; was never connected with the upper Ohio drainage by a canal; and, finally, it was found, that several Naiades present in this river could not have found their way into it by having been transferred from the upper Ohio drainage by stream piracy, simply because they are not present in this part of the Ohio drainage.

In order to present all the facts at my disposal, I first give

a list of my own (and previous) distributional records. (See: map fig. 1.)

Fig. 1.



TRIBUTARIES OF LAKE ERIE IN N. E. OHIO.

CHAGRIN RIVER. (Lower part polluted by paper mill at Chagrin Falls.)

1. Ch. R., Willoughby, Lake Co., O. (Sept. 10, '20.)
   Lampsilis siliquoidea (*Barn.*) *Lampsilis ovata ventricosa* (*Barn.*)
2. Ch. R., Cuyahoga Co., O. (Hartman coll.)
   Lampsilis ovata ventricosa (*Barn.*)
3. Ch. R., Gates Mill, Cuyahoga Co., O. (seen, Sept. 9, '20.)
   Lasmigona costata (*Raf.*) *Lampsilis ovata ventricosa* (*Barn.*)
4. Ch. R., below Chagrin Falls, Cuyahoga Co., O. (seen, Sept. 8, '20.)
   Lampsilis siliquoidea (*Barn.*)
5. Ch. R., Russell Twp., Geauga Co., O. (above falls) (Sept. 8, '20.)

Lasmigona compressa (*Lea*) — *Anodontoides ferussacianus* (*Lea.*)
Lasmigona costata (*Raf.*) — *Strophitus rugosus* (*Swains.*)
Anodonta grandis Say

6. Aurora Branch, Chagrin Falls, Cuyahoga Co., O. (Sept. 8, '20.)
Lasmigona compressa (*Lea*)

GRAND RIVER. (Everywhere in good condition, without any pollution.)

1. Painesville, Lake Co., O. (Sept. 11, '20.)

Fusconaia flava (*Raf.*) — *Ptychobranchus fasciolare* (*Raf.*)
Amblema costata Raf. — *Obovaria subrotunda lens* (*Lea*)
Pleurobema cordatum coccineum (*Conr.*) — *Actinonaias carinata* (*Barn.*)
Proptera alata (*Say*)
Elliptio dilatatus (*Raf.*) — *Micromya iris novi-eboraci* (*Lea*)
Lasmigona costata (*Raf.*) — *Ligumia recta latissima* (*Raf.*)
Alasmidonta marginata (*Say*) — *Lampsilis siliquoidea* (*Barn.*)
Strophitus rugosus (*Swains.*) — *Lampsilis ovata ventricosa* (*Barn.*)

Of these, *Strophitus rugosus* and *Lampsilis ovata ventricosa* have been mentioned before from the same place by Simpson (in: Kirsch, '95.) The Carnegie Museum possesses *Actinonaias carinata* also from the Sterki collection.

2. Eaglesville, Ashtabula Co., O. (Sept. 16, '19.)

Fusconaia flava (*Raf.*) — *Anodonta grandis Say*
Amblema costata Raf. — *Ptychobranchus fasciolare* (*Raf.*)
Pleurobema cordatum coccineum (*Conr.*) (seen) — *Obovaria subrotunda lens* (*Lea*)
Micromya iris novi-eboraci (*Lea*)
Elliptio dilatatus (*Raf.*) — *Ligumia recta latissima* (*Raf.*)
Elliptio complanatus (*Dillw.*) — *Lampsilis siliquoidea* (*Barn.*)
Lasmigona costata (*Raf.*) — *Lampsilis ovata ventricosa* (*Barn.*)

3. Rockcreek, Ashtabula Co., O. (Sept. 8, '19.)

Fusconaia flava (*Raf.*) — *Obovaria subrotunda lens* (*Lea*)
Amblema costata Raf. — *Actinonaias carinata* (*Barn.*)
Elliptio dilatatus (*Raf.*) — *Micromya iris novi-eboraci* (*Lea*)
Lasmigona costata (*Raf.*) — *Ligumia recta latissima* (*Raf.*)
Anodonta grandis Say — *Lampsilis siliquoidea* (*Barn.*)
Ptychobranchus fasciolare (*Raf.*) — *Lampsilis ovata ventricosa* (*Barn.*)

4. North Bloomfield, Trumbull Co., O. (Sept. 17, '19.)

Fusconaia flava (*Raf.*) — *Lasmigona costata* (*Raf.*)
Amblema costata Raf. — *Obovaria subrotunda lens* (*Lea*)
Pleurobema cordatum coccineum (*Conr.*) — *Micromya iris novi-eboraci* (*Lea*)
Lampsilis siliquoidea (*Barn.*)
Elliptio dilatatus (*Raf.*) — *Lampsilis ovata ventricosa* (*Barn.*)

In addition, Call ('85 p. 9) gives *Anodontoides ferussacianus buchanensis* (*Lea*) from Grand River, and Sterki ('07 p. 394) mentioned this under the varietal name of *subcylindracea* (*Lea*). This form is hardly different from the normal *A. ferussacianus*.

RED BROOK, 3 m West of Harbor, Ashtabula Co., O. (Sept. 13, '20.)
(A very small stream; shells found dead within a mile from the lake.)

Lasmigona compressa (*Lea*) *Anodontoides ferussacianus* (*Lea*)

CONNEAUT CREEK (in good condition for its whole length.)

1. Kingsville, Ashtabula Co., O. (Sept 12, '20.)

Pleurobema cordatum coccineum (*Conr.*)
Lasmigona compressa (*Lea*)
Lasmigona costata (*Raf.*)
Anodontoides ferussacianus (*Lea*)
Alasmidonta marginata (*Say*)
Strophitus rugosus (*Swains.*)
Ptychobranchus fasciolare (*Raf.*)
Micromya iris novi-eboraci (*Lea*)
Lampsilis siliquoidea (*Barn.*)
Lampsilis ovata ventricosa (*Barn.*)

2. West Springfield, Erie Co., Pa. (May 23, '09) (published in '19.)

Pleurobema cordatum coccineum (*Conr.*)
Elliptio dilatatus (*Raf.*)
Lasmigona compressa (*Lea*)
Anodonta grandis Say
Anodontoides ferussacianus (*Lea*)
Alasmidonta marginata (*Say*)
Strophitus rugosus (*Swains.*)
Ptychobranchus fasciolare (*Raf.*)
Micromya iris novi-eboraci (*Lea*)
Lampsilis siliquoidea (*Barn.*)
Lampsilis ovata ventricosa (*Barn.*)

3. Springboro, Crawford Co., Pa. (June 4, '08) (published in '19.)

Pleurobema cordatum coccineum (*Conr.*)
Strophitus rugosus (*Swains.*)
Lampsilis siliquoidea (*Barn.*)
Lampsilis ovata ventricosa (*Barn.*)

The Naiad-fauna of these streams consist of 19 species, and is rather uniform, with the qualification, that the largest (Grand River) contains more species than any of the others. Grand River has 6 species not found in the others (*Fusconaia flava, Amblema costata, Elliptio complanatus, Obovaria subrotunda lens, Actinonaias carinata, Proptera alata.*) Two species found in other streams (*Lasmigona compressa* and *Anodontoides ferussacianus*) have not been found recently in the Grand (the latter, however, has been reported by Call), but they apparently have been missed by myself only by accident. Since these two species are unimportant for our present purpose, we may safely take the *Grand River fauna as typical for this region,* and restrict our further discussion chiefly to this river.

Of the shells found here the following are found in the upper Ohio drainage, but differ more or less from the lake-form; in most cases, different names are in use, as indicated below (see: Grier, '18, Ortman, '19, Grier, '19.)

In Grand and Ohio	In the lake
1. *Fusconaia flava* (*Raf.*)	*Fusconaia flava parvula Grier*
2. *Amblema costata Raf.*	*Amblema plicata* (*Say*)
3. *Pleurobema cordatum coccineum* (*Conr.*)	*Pleurobema cordatum pauperculum* (*Simp.*)
4. *Elliptio dilatatus* (*Raf.*)	*Elliptio dilatatus sterkii Grier*
5. *Lasmigona costata* (*Raf.*)	*Lasmigona costata eriganensis Grier*
6. *Strophitus rugosus* (*Swains.*)	*A dwarf form* (Ortmann, '19 p. 200)
7. *Ptychobranchus fasciolare* (*Raf.*)	*A dwarf, humped form* (Ortmann, '19 p. 210)
8. *Obovaria subrotunda lens*(*Lea*)	*Obovaria subrotunda leibi* (*Lea*)
9. *Proptera alata* (*Say*)	*A smaller, more swollen form* (Ortmann, '19 p. 254 and Grier, '19 p. 165)
10. *Ligumia recta latissima* (*Raf.*)	*Ligumia recta* (*Lam.*)
11. *Lampsilis siliquoidea* (*Barn.*)	*Lampsilis siliqoidea rosacea* (*DeKay*)
12. *Lampsilis ovata ventricosa* (*Barn.*)	*Lampsilis ovata canadensis* (*Lea*)

Thus it is seen, that in over half of the cases (12 out of 19) the fact is established, which has been indicated in the beginning: *that the Naiades of the Lake Erie tributaries resemble those of the Ohio drainage more closely than those of the lake itself.*

The other species of Grand River have the following distribution and affinities.

13. *Alasmidonta marginata* (*Say*) 14. *Actinonaias carinata* (*Barn.*)

Both are species found in the identical form in the upper Ohio drainage, and are present in other tributaries of the lake; but in the lake itself they are absolutely missing. For our further studies, these two species will be very important.

15. *Micromya iris novi-eboraci* (*Lea*) (see: Ortmann, '19 p. 270.)

This species stands by itself. It is characteristic for the lake-drainage from New York to Michigan, both in Lake Erie and its tributaries, but it is not found in the upper Ohio drainage, where its place is taken by the typical *Micromya iris* (*Lea*). We have here a case of an identical form in the lake and its tributaries, but different from the Ohio-form.

16. *Lasmigona compressa* (*Lea*)

This is found in the upper Ohio drainage, in tributaries of the lake, and in the lake proper. Its value for distributional

studies is thus doubtful. But the fact that it is extremely rare in the lake (only 2 specimens ever recorded, one from Presque Isle, Pa., the other from Sandusky Bay, O.,) approaches this species to those which are not in the lake (Nos. 13 and 14 above.) It has the appearance, as if this species abundant and flourishing in tributaries and small streams in general, does not take kindly to the lake-environment.

17. *Elliptio complanatus* (*Dillw.*)

This is an abnormal case. It is an Atlantic species, not found in the upper Ohio and not elsewhere in the Erie drainage. I shall discuss this case at the end.

18. *Anodonta grandis Say* 19. *Anodontoides ferussacianus* (*Lea*)

These will be left out of consideration. Although in both the lake-form is somewhat different from that of the tributaries, and although the latter again generally resembles the Ohio-form, the various forms are not strictly separated along these lines. *Anodonta grandis footiana* (Lea), the lake-form, has been frequently reported from the Ohio-drainage, and in *Anodontoides* the same condition apparently prevails; but in this case the forms require further investigation, the var. *buchanensis Lea,* generally attributed to the lake, probably having been misunderstood.

THE THEORY OF THE CROSSING OVER THE DIVIDE.

(See: map fig.1)

There has never been a canal connecting the headwaters of Grand River with the Ohio system. This is true also of Chagrin River, but is different in the case of Conneaut Creek, where the headwaters come into contact with those of the upper Beaver (Shenango) River and French Creek (tributaries to Ohio, respective Allegheny.) This region was traversed by the old Beaver Canal, and I have suggested ('19) the possibility, that Conneaut Creek might have received some of its shells by this route (from Shenango River in Pennsylvania.) But since the species, which might have taken this route (*Pleurobema cordatum coccineum, Elliptio dilatatus, Lasmigona costata, Alasmidonta marginata, Strophitus rugosus, Ptychobranchus fasciolare, Lampsilis siliquoidea, Lampsilis ovata ven-*

tricosa) are not peculiar to this system, and possess all a rather general distribution, being also found in Grand River, where there was no canal, *this way of migration is for Grand River excluded*, although it should be admitted as a possibility for Conneaut Creek.

The canal-theory deserves more consideration in the case of Cuyahoga River, the next tributary of the lake to the West of Chagrin River. This was connected by a canal with the Tuscarawas-Muskingum system of the Ohio. In Cuyahoga River there is at least one species of the Tuscarawas drainage, *Lasmigona complanata* (*Barn.*), which is not found in the lake, and just this species favors the canal-environment.*

The headwaters of Grand River closely interlock with that of the Beaver drainage, in fact, they are almost surrounded by it (Mosquito and Eagle Creeks, tributaries to Mahoning River), with the exception of the western side, where they come into contact with the headwaters of Cuyahoga River.

The upper Cuyahoga has a history of its own, and probably a rather complex one. It might once have belonged to the Tuscarawas drainage (Newberry, '73 pp. 204, 205); but the heavy, stratified gravels between the bend of the Cuyahoga and the Tuscarawas (near Akron) are considered glacial outwash by others (Leverett, '02, passim, and map. pl. 15.) There also might have existed here a large glacial lake, connected at different times toward the South and toward the North. For this reason it seems well to consider also this river in the following studies.

The Naiad-fauna of these rivers (Cuyahoga, Tuscarawas, and Mahoning) is well known† and of the shells mentioned above, the following distributional facts should be emphasized.

1. *Fusconaia flava.*—Missing in the whole Beaver (Shenango and Mahoning) drainage (Ortmann, '19 p. 17), but present in the uppermost Tuscarawas, near Akron; not in the upper Cuyahoga.

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*The Cuyahoga fauna has other peculiarities, which deserve special discussion, but I cannot go into detail here. Some of the facts will be alluded to below.

†See: Dean, '90, Sterki, '07, and my own collections, partially published in '19.

2. *Actinonaias carinata.*—Missing in the upper Mahoning (Ohio part of it), and in the Shenango above Sharon, Pa. (Dean, '90, Ortmann, '19 p. 236); present in the Tuscarawas, but not in the headwaters above New Philadelphia (Sterki collection in Carnegie Museum); not in upper Cuyahoga.

3. *Proptera alata.*—Missing in the whole Beaver drainage (Ortmann, '19 p. 256), missing in the Tuscarawas (Sterki, '07 p. 393), and missing in upper Cuyahoga.

4. *Ligumia recta latissima.*—Missing in the Beaver drainage (Ortmann, '19 p. 280); present in Tuscarawas, but not in the upper part (above New Philadelphia) (Sterki collection); not in upper Cuyahoga.

Thus these 4 species are not found in that part of the Ohio-drainage which comes into contact with Grand River, and they are also absent in the upper Cuyahoga. For these, at least, the assumption of a crossing of the divide by stream-capture is positively excluded.

For the other species the following facts of distribution have been ascertained.

The following species are found in the upper Mahoning, upper Tuscarawas, but not in the upper Cuyahoga:

1. *Amblema costata*
2. *Pleurobema cordatum coccineum*
3. *Elliptio dilatatus*
4. *Lasmigona costata*
5. *Alasmidonta marginata*
6. *Ptychobranchus fasciolare*
7. *Obovaria subrotunda lens*
8. *Lampsilis ovata ventricosa*

Two more species are in all three systems:

Strophitus rugosus *Lampsilis siliquoidea*

The possibility must be granted that these last 10 species might have come into Grand River from the adjoining Ohio-tributaries, presumably by stream capture. However, in 8 of them, the upper Cuyahoga (if it ever was a tributary of the Tuscarawas) is excluded, and only in the last 2 species this latter river might come into question. But these two species are of such a general distribution, that they do not furnish any conclusive argument. The other 8 species, if they have

come from the South, could have come only from the Mahoning system.*

Although there are 8 cases, which would admit the theory that shells have been transferred from the upper Mahoning into Grand River by stream capture, there are 4 others, which are positively opposed to it. Moreover, there is no physiographical evidence for stream capture in this region. The divides are all ill-defined here, and, although a mingling of the waters is possible (and actually present at certain points), this concerns extremely small streams, into which no Naiades have advanced.

In order to support this conclusion, I may be permitted to introduce here the evidence furnished by the distribution of certain crayfishes (genus *Cambarus*). These creatures advance much farther toward the headwaters, than the Naiades, nevertheless their evidence is distinctly opposed to the theory that they have crossed the divide.

Grand River possesses the species *Cambarus propinquus Gir.*, characteristic for Lake Erie and many of its tributaries (also farther North and West), and this species is also in Ashtabula River and Chagrin River. The upper Mahoning River

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*It might be interesting to say a few words about the upper Cuyahoga fauna. This consists of the following species (Dean, '90; Sterki and Ortmann collections in Carnegie Museum.)

Lasmigona compressa (*Lea*)	*Anodontoides ferussacianus* (*Lea*)
Lasmigona costata (*Raf.*)	*Strophitus rugosus* (*Swains.*)
Anodonta grandis Say	*Ligumia nasuta* (*Say*)
Anodonta imbecillis Say	*Lampsilis siliquoidea* (*Barn.*)

There is no evidence in this fauna for the former connection of the upper Cuyahoga with the Tuscarawas. The presence of *Anodonta imbecillis*, which is a form also found in the Tuscarawas, preferring lake and canal environment, cannot be introduced in favor of this assumption, for this species has a rather erratic range (also in Lake Erie basin.) *Ligumia nasuta*, a characteristic form of the lake, is a very peculiar type of shell in this region; it also is a typical lake-dweller. It is found nowhere else in northern Ohio in tributaries of the lake (except some very small and sluggish ones close to the lake in the vicinity of Toledo), and is also absent in the Maumee River. Possibly both species, *Anodonta imbecillis* and *Ligumia nasuta* are remnants of the fauna of a lake of good size (mentioned above), which once existed in this region, and was connected with Lake Erie by the lower Cuyahoga.

(as well as the whole Beaver drainage) has *Cambarus obscurus Hag.*, the form of the uppermost Ohio-drainage (including Allegheny and Monongahela.) In Conneaut Creek, both species are found, and here we may take it for granted, that the old Beaver-canal has acted.

From the Cuyahoga, the lake species (*C. propinquus*) has not been reported (but it is in Rocky River, a little to the West) : however, it may turn up here yet. In the upper parts of this drainage, in the Cuyahoga and its tributaries, as well as in several lakes, I found only *Cambarus propinquus sanborni* (*Fax.*), the form of the Tuscarawas and Muskingum Rivers: this surely indicates a closer connection of the upper Cuyahoga and the Tuscarawas, but it remains doubtful, whether this is due to old drainage-features, or to the modern canal.

This much is sure, that by the evidence furnished by both the Mussels and the Crayfishes of Grand River no stream piracy is probable in this region, and that there are cases which positively speak against it.

Of the four species of Naides, which could not have come from the Mahoning, none is found in Lake Erie. *Actinonaias carinata* is altogether missing there, and the three others (*Fusconaia flava, Proptera alata, Ligumia recta latissima*) are represented by more or less distinct forms. Yet all of these are present in other tributaries of the lake. Disregarding the Maumee (in which all four are present), but which is supposed to have been the route of immigration of all Ohio-types, we have them in the following rivers: Grand River in Ontario (all except *Ligumia*) ; lower Cuyahoga (all, but *Fusconaia* might have come from the Tuscarawas, which is excluded in the other three) ; Vermilion River (only *Proptera*) ; Sandusky River (all four) ; Raisin River, Mich. (*Fusconaia* and *Actinonaias*) ; Huron River, Mich. (*Actinonaias* and *Ligumia.*) In the cases of Grand River, Ont., Raisin and Huron Rivers, Mich, the argument also holds good, that these species could not have come from the Ohio drainage, since these systems do not come in contact with the latter.

This means that these four species, at present, have a *discontinuous distribution,* being found in a number of tribu-

taries of Lake Erie, but with the ranges separated by the body of the lake, and the same assumption, of course, is admissible, although not positively demonstrated, in all other cases here discussed. Thus a theory, which explains these four cases, also could be used in the others, although as an alternative it is not excluded, that they might have come across the divide from the upper Ohio at least in the state of Ohio.

Additional species which might fall under the same category with the above, and chiefly with *Actinonaias carinata*, are: *Alasmidonta marginata* (*Say*) and *Lampsilis fasciola Raf.* Both are not found in the lake. The former is in Grand R., Ont., in Raisin R., Mich., in Sandusky, Cuyahoga, Grand Rivers, O., and Conneaut Creek. The latter is known only from Raisin R., Mich., and Sundusky R., O. (both are in the Maumee.) Immigration into the tributaries of the lake in Ohio from the South is here also thinkable; but these species have the same *discontinuous* distribution in the lake tributaries, as the twelve mentioned above, and a theory explaining this discontinuity would also serve in their case.

It is clear, that such a theory should reconstruct a former connection of the now separated river-systems, a union of them into one system, to which they were tributaries.

THE NEW THEORY.

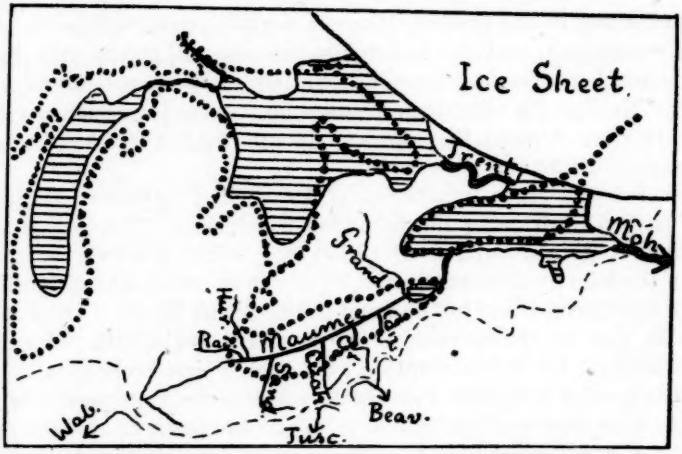
Turning to the glacial history of the lake, we find that indeed there was once such a drainage condition represented during the stages of the so called *Trent* and *Nipissing Outlets*, the former a little earlier, the latter a little later toward the end of the Glacial time. Both are characterized by the peculiarity, that the waters of the upper lakes (Superior, Michigan, Huron, at a certain time called Lake Algonquin) did not flow to Lake Erie (Detroit River route), but were flowing, in the Trent stage, from Georgian Bay of Lake Huron directly to Lake Ontario (Lake Iroquois), and, in the Nipissing stage, by way of Lake Nipissing to the lower St. Lawrence valley (at that time invaded by the Champlain Sea) (See map fig. 2)*

At this time, Lake Erie, at present a rather shallow body of

* See maps: Chamberlin & Salisbury, 3. '06 p. 401 fig. 521 and p. 404 fig. 522; also: Walker, '13 p. 44 fig. 4.

water, was practically dry, possibly only with a small remnant of a lake at its eastern end (near Buffalo), and, consequently, Maumee River, entering the basin at its western end, must have traversed it in the direction of its long axis, so that all the present tributaries of the lake (except possibly the most eastern ones) *must have been tributaries of this continuation of Maumee River.*

Fig. 2.



TRENT OUTLET STAGE OF GREAT LAKES.

Adapted from Walker, Naut. 27, 1913, p. 44 fig. 4.

Thus we obtain a system of connected rivers, an enlarged Maumee-system, collecting all the tributaries in which the Naiades here discussed are found, and this system had a continuous fauna, the Maumee fauna, which, as Walker has shown ('13) was mainly derived from the Wabash River, a tributary of the Ohio.

Later on, after the Trent and Nipissing Outlets were closed (the latter by a re-elevation of the continent in the North-East), the waters of the upper lakes were turned again, by way of Detroit River, into the Lake Erie basin, filling it up, and drowning the lower Maumee and the lower parts of its

tributaries. Only the upper parts of the latter persisted as rivers, becoming tributaries of the lake, and containing, up to the present time, the remnants of the once continuous fauna, now become *discontinuous*. In the new Lake Erie, the fauna, either died out (*Actinonaias carinata, Alasmidonta marginata, Lampsilis fasciola*), or (in most cases) changed under the influence of the different lake environment, producing those forms, which we know now as the representative lake-forms of the original river-types.

Of course, we should expect the old Maumee-fauna best preserved in the present Maumee (upper part of Maumee of Trent-stage), and this is actually the case: all the species discussed here (and many additional Ohio-types) are found in the Maumee.*) But this requires no special discussion, since this river formed the highway along which the Ohio-fauna migrated into the Erie basin.

For the other tributaries of Lake Erie, however, we are justified in drawing the following conclusion. The fact, that they contain a number of Ohio-types, which are represented in the lake by different forms, or not at all, must be explained, in the Grand River of Ohio and in the Grand River of Ontario, and also in tributaries at the western end of the lake in Michigan, by the assumption *that these rivers were at a certain time tributaries of an old Maumee River, continued along the Erie basin*, which was dry. This was towards the end of the Glacial Period, at the stages in the development of the Great Lakes known as the *Trent and Nipissing Outlet stages*. This continuous and connected river-system was rendered discontinuous by the re-filling of Lake Erie in Post-Champlain time. In the rivers named, this assumption is *imperative*, because an immigration from the Ohio-system (other than by the Wabash-Maumee route) is excluded.

Furthermore, if this is correct, nothing prevents the assumption that also in other tributaries the same explanation holds good. There is, indeed, the possibility, that in other

* A remarkable exception is *Ligumia nasuta*, which is not in the Maumee; this species stands by itself. It is of western origin, but apparently has a history of its own, being possibly one of the oldest immigrants into the lake-basin.

rivers in the state of Ohio some faunal elements of the upper Ohio drainage may have reached the lake-tributaries by stream-piracy in the region of the headwaters. But such forms cannot be singled out, since they do not differ from those which used the Maumee-route. In addition, some forms may have reached the lake-basin in very recent times, coming from the upper Ohio by canals, as in the cases of Conneaut Creek and Cuyahoga River, but such cases seem to be very few (one has been indicated above.) The Miami-Maumee and the Wabash-Maumee canals of recent times may also have helped to introduce additional Ohio-types into the lake-basin, and, indeed, there are several species known, where this might be suspected. But this is outside of the scope of the present paper, and, moreover, it concerns the same region covered by the old Wabash-Maumee route of immigration.

THE CASES OF MICROMYA IRIS NOVI-EBORACI AND ELLIPTIO COMPLANATUS.

Of the shells which compose the fauna of Grand River, two additional cases require further discussion.

Micromya iris novi-eboraci is found in the lake, in the Maumee, and a number of the lake-tributaries, but it is not in the upper Ohio-drainage, being represented there by *Micromya iris* (*Lea.*) The lake-form is not distinguishable from the form of the tributaries. In this case we may assume, that the form *novi-eboraci* came in recent times from the Maume into the lake, and then ascended into the tributaries. But, of course, there is no objection to the assumption, that it also is a remnant of the Trent-Nipissing stage, but that here the form has not changed in the lake. A few additional, similar cases are known: *Quadrula pustulosa prasina* (*Conr.*) (represented in the upper Ohio by *Quadrula pustulosa* (*Lea*); *Dysnomia sulcata delicata* (*Simp.*) (not in upper Ohio); and the following species which, although present in the Ohio-drainage, are not found in the tributaries in northeastern Ohio and northwestern Pennsylvania: *Quadrula quadrula* (*Raf.*), *Obliquaria reflexa Raf.*, *Truncilla truncata Raf.*, *Truncilla donaciformis* (*Lea*). For all these the same holds good as for *Micromya iris novi-eboraci.*

Finally, *Ellipto complanatus* (*Dillw.*) in Grand River is an anomalous case. This is a common Atlantic species, missing in the whole interior basin. Yet I have found a single individual, and Sterki ('07 p. 393) has reported a single shell from the Tuscarawas drainage near New Philadelphia, O., (collected in 1898; the specimen is now in the Carnegie Museum.)

This species is known from the St. Lawrence and Lake Ontario along the Nipissing and Trent routes to northern Lake Huron and the eastern part of Lake Superior (see map given by Walker, '13 p. 30 fig. 2), but does not go thence southward into the southern part of Lake Huron, and has never been found in Lake Erie.

Walker ('13 p. 45) connects this range with the *Trent Outlet stage,* and thinks that this species came from the Mohawk Outlet of Lake Iroquois (Ontario) up the Trent River into Lake Huron. This undoubtedly is correct, and it should be added that another species took the same route: *Lampsilis radiata* (*Gmel.*) (often called *borealis Gray.*) It is found practically in the same region, from New York state and the St. Lawrence to Lake Huron in the Georgian Bay region, but it does not go farther West.

The occasional presence of *Elliptio complanatus* in Grand River, and even in the Tuscarawas, is very astonishing. The only explanation I can think of, is the following.

Since there is, apparently, no natural barrier to the dispersal of this species from Lake Huron southward into Lake Erie, *Elliptio complanatus might be expanding its range in this direction at the present time,* not only into Lake Erie, but also into some of its tributaries, for instance Grand and Cuyahoga Rivers, and from the latter it might have reached the Tuscarawas by the canal. But only the forerunners, occasional individuals, are arriving. They might be also in the lake, but have not yet been discovered. It would be interesting to watch the further progress of this colonization. Of course we know that here, as generally among mussels, the dispersal probably is by transport in the larval stage by fishes,

but what we know about this shell in this respect does not furnish any additional information.*)

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* The fish-host of this species is not positively known. Lefevre & Curtis (Bull. Bur. Fish. 30. '12 p. 168) have succeeded in *artificially* infecting the Yellow Perch (*Perca flavescens*) with the glochidia of *Elliptio complanatus*.

Apios tuberosa Moench.

THEO. HOLM.

(With 14 figures drawn by the author.)

Considering the large number of perennial herbs represented by the *Papilionaceae*, it is remarkable to notice, how very few of these are equipped with rhizomes of any singular, characteristic structure. Pseudo-rhizomes are undoubtedly the prevailing type, with or without stolons; many of the species spread by means of such stolons, some few by rootshoots; only one, so far as we have observed, is capable of spreading by stolons as well as by root-shoots, namely *Lupinus perennis* L. The root-system shows also a very uniform structure, from a large tap-root to the ordinary filiform, profusely branched; the characteristic swollen storage-roots we know from *Galactia, Indigofera, Psoralea,* and *Pachyrhizus*. But rhizomes in the stricter sense of the word are very poorly exemplified. We have seen the peculiar, tuberous rhizome of *Lathyrus macrorhizus,* described by Warming, (1) which is formed by a section of the stem just above and below the cotyledons, besides that similar tuberous "nodi" may occur here and there, upon the subterranean shoots. Another type of tuberous rhizome and presumably one which is unique in this family, is the one known so well from the "Ground-Nut," *Apios tuberosa*. The rhizome of this plant shows a structure so peculiar, that it has been mistaken for a root. While Gray described it as "bearing edible tubers on underground shoots," Torrey called it "a root producing fleshy tubers, arranged at intervals like beads;" Taubert considered it to represent a root. But the anatomists, who examined the internal structure reached the correct conclusion, that the tuber is a part of a true rhizome. Nypels and Seignette have given a very detailed description of the internal structure, which shows several points of interest.

(1) For references consult the bibliography appended

From a comparative point of view very little is known, so far, about the structure of the aerial, vegetative organs, except that Trécul has described the secretory ducts. No other reference to the genus is given in Solereder's work on the anatomy of the Dicotyledons.

Apios being very frequent in swamps and moist thickets in our vicinity, we have studied a number of specimens during the last year, and the following notes are the result of our observations.

The external structure of the seedling and of the rhizome of the mature plant.

The seedling of *Apios*, (Fig 1) resembles that of most of the other members of the family with hypogeic cotyledons, and shows no indication of the singular structure of the subterranean stem of the older plant. The primary root (Fig. 1) is long and slender and ramified, but without tubercles. The epicotyl is erect, tall, and rooting at the base. The leaves are unifoliolate, the first two being almost opposite; they subtend axillary buds. The cotyledons remain enclosed within the seed, and the axillary buds evidently develop into subterranean shoots.

While the typical structure of the rhizome of the mature plant is moniliform, with rather numerous tuberous enlargements, some modifications occur. The ramification of the rhizome varies also to some extent; a monopodium is the most frequent type, however. But characteristic of the mature rhizome is the early withering of the foliage, the minute, membranaceous, scale-like leaves, thus it is not possible to determine with any certainty where the internodes begin or end. And as will be shown in the subsequent pages neither the tubers nor the slender stem-portions between these represent single internodes. A typical structure is shown in figure 2, where the small tubers are in their second year of growth, while in figure 3 they are just about to be formed.

Normally the aerial shoot, the vine, develops from the apex of the terminal tuber, the basal internodes of the vine may persist for a few years, and the buds in the axils of the small, scale-like leaves develop into aerial shoots. Subterranean shoots, at first resembling slender stolons (S in fig. 2), but

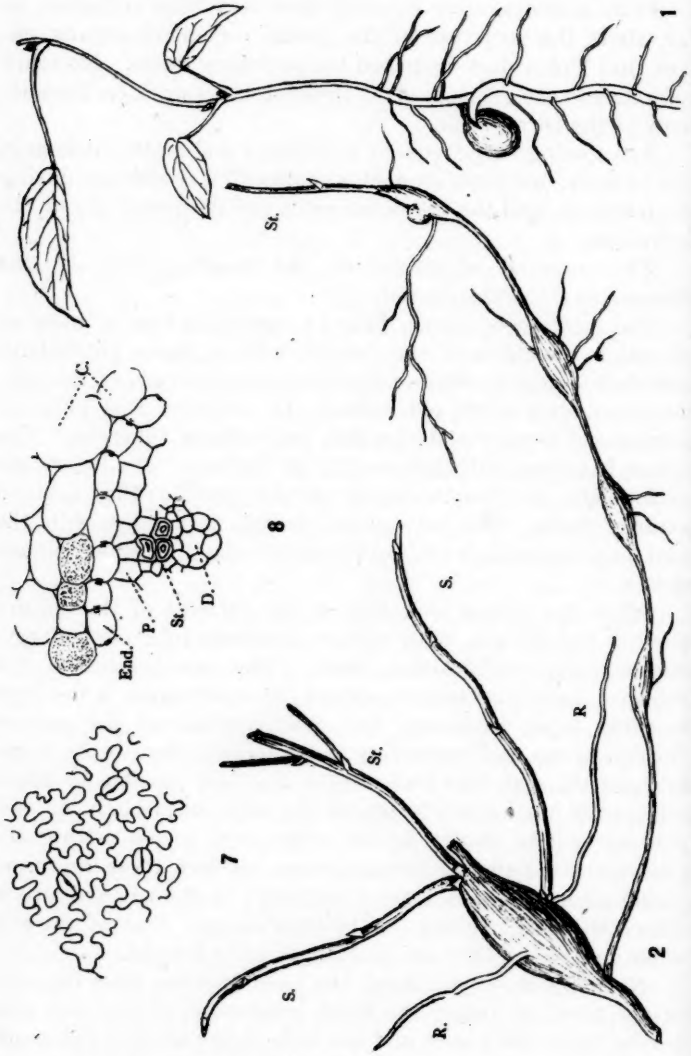

PLATE VII.

during the summer becoming tuberiferous, may develop close to the apex, at the middle, or at the base of the terminal tuber; or, less frequently, they may develop from any of the other tubers, which constitute the rhizome. But we have never observed a single case, where stolons were developed from the slender part of the rhizome. The slender portion together with the base of the tuber thus represents an internode, while the tuber itself is composed of at least two internodes, judging from the position of the stolons. The small, scale-like leaves of the stolons (Fig. 2) wither as soon as the tubers begin to be formed, and disappear completely. The roots are exclusively confined to the tubers; they are sparingly branched, and bear bacterial tubercles (Fig. 3.)

Extensive rhizome systems represent a growth of several years, depending on a single tuber, as the large one in figure 2, which shows three generations of aerial shoots and two of subterranean stolons, one slender, and one tuberiferous. In figure 3 only one very long stolon is developed, which is about to form tubers. These two figures (figs. 2 and 3) represent the rhizomes of two individuals, collected respectively in May (fig. 2), and in July (fig. 3.) The system of axes, aerial as well as subterranean, is developed in each case from a single tuber. In figure 2 the bases of two aerial shoots (St) are to be seen at the apex of the tuber. Two slender stolons (S) with small scale-like leaves, and with long internodes proceed from the same tuber, the one from near the apex, the other from near the middle. They grow in a horizontal direction, and having reached a certain length, cease growing. The terminal bud remains dormant until the succeeding spring, when it develops into an aerial shoot which is generally purely vegetative for several years. During the first summer, however, the stolons begin to increase in thickness at intervals, and this increase in thickness is accompanied by the development of several roots, while the slender parts of the stolons never produce roots. This stage is drawn in figure 3, the stolon showing increase in thickness at four different places. The apex of the stolon in this case has been injured, but as may be seen from the figure (fig. 3) a small, lateral branch has pushed out at the base of the terminal one. In figure 2, there is besides the

PLATE VIII.

two slender stolons a third one, which proceeds from the base of the large tuber, and has developed four very distinct tubers, of which the terminal is extended into an aerial shoot (St.), besides that it has also developed a small, lateral tuber, which is sessile—a very rare occurrence as it seems. This tuberiferous stolon thus corresponds with the very long stolon in figure 3, but it is one year older; and the difference in age between the stage of the slender stolons (figure 2) and the very long one just beginning to form tubers (figure 3) is only about three months.

At the apex of the tubers there is a terminal bud which may develop in either of two ways according to the position of the tuber. When the stolons are not prevented from continuing their growth horizontally beneath the surface of the soil the terminal bud as shown in figure 2 produces, or better, becomes extended into an aerial shoot. But, when the apex of the stolon is injured, as shown in figure 3, an axillary bud takes its place (figure 6) and continues the growth as a stolon for some time, or as an aerial shoot in the succeeding spring. As shown in figure 6 the apex of the young tuber bears a few scale-like leaves, two of which subtend axillary buds. These small leaves at the apex are not visible on the other tubers, nor is there any indication of similar leaves at the middle or at the base of the tubers in general. However, as has been mentioned above, the fact that stolons may develop at various parts of the tuber seems to indicate that some leaves must have been present, but having withered without leaving any scars. It does not seem probable that these lateral shoots upon the tuber owe their development to adventitious buds, since we observed them in similar relative positions in a number of specimens without any trace of subtending leaves.

The ramification of the tuber thus results in the development of a terminal, aerial shoot, the vine, and of several lateral shoots, all becoming subterranean stolons, which are monopodia, at least for some time. Moreover, the tuber persists in an active condition for several years, giving rise to new sets of stolons as shown in figure 2. It is characteristic of the roots that they are developed only upon the tubers. We never observed the development of roots from the slender parts of

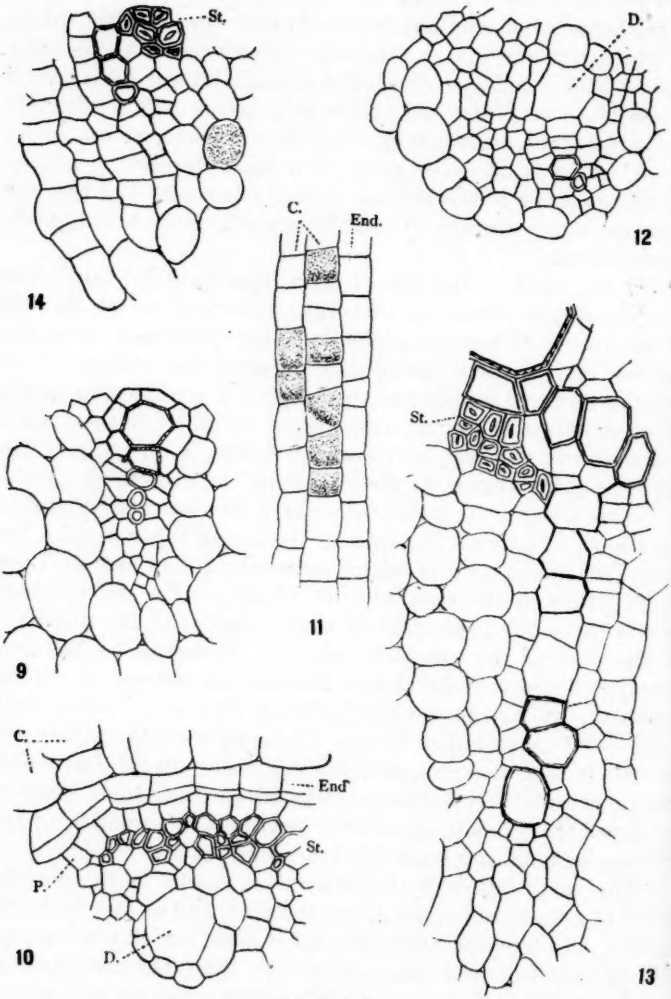

PLATE IX.

the rhizome. In rhizomes, in which the increase in thickening is less abrupt and less pronounced than in those figured, the root-system does not extend to the whole surface of the rhizome, but is restricted to certain portions scattered at intervals along the rhizome just as in the normal specimens.

Considered from a biological point of view *Apios* is well equipped for distribution by vegetative organs; its frequent occurrence, generally in abundance, is due to the development of tubers, rich in food-substances, thus capable of starting new individuals, when disconnected.

Internal structure of the vegetative organs.

THE ROOT-SYSTEM.

The secondary roots of a mature sepecimen (Fig. 8) show the following structure during the first season. Root-hairs are absent; the epidermis is thinwalled, and there is no hypoderm. The cortex is homogeneous, and consists of about ten compact strata with no deposits of starch, but several of the cells, especially close to the endodermis contain a solid, dark-brown or purplish substance, which is insoluble in alcohol. Balls of hyphae were observed in this parenchyma. The endodermis is thinwalled and destitute of starch. The pericambium, as usual, is a single stratum surrounding the stele. The stele is tetrarch with a wide vessel in the center, and the four rays are relatively short. The leptome represents a broad strand with a few stereids, of which the cell-walls are gelatinous, and a wide duct with distinct epithelium is located just inside the stereome; the duct contains a granular, colorless latex, and no tannin was observed in any parts of the root. No secondary increase was observed.

A corresponding structure recurs in the secondary and lateral roots of the seedling, but no stereids were observed in these. The primary root of the seedling, which is short-lived, lacks the stereome, but shows a slight increase in thickness within the stele only, there being eight mestome-strands and a relatively broad pith with deposits of starch. The brown or purplish substance, observed in the secondary root of the mature specimen, occurs also in the cortex of the primary root, but not in any of the other roots of the seedling.

THE AERIAL STEM.

The internodes are obtusely quadrangular (in cross-section) with a corresponding stele of about sixteen collateral mestome-strands and a broad, solid pith. The cuticle is smooth, thick, and the outer cell-wall of epidermis is thick. The stomata are sunk. The cortical parenchyma consists of four strata, of which the two peripheral are slightly collenchymatic; many of the cells, and frequently three or four together, contain a dark brown, solid substance, insoluble in alcohol. Inside the cortex is a thin-walled endodermis with the Casparyan spots plainly visible, but containing no deposits of starch. Inside the endodermis is an almost continuous sheath of stereome with gelatinous walls, in about five layers; it is interrupted here and there by short rays of thin-walled parenchyma extending from the interfascicular cambium. The mestome-strands represent a single band. The leptome forms large groups, and contains one or two wide ducts with epithelium, and filled with a clear, amorphic substance. The hadrome is also well represented with several porous vessels near the periphery, and some narrow spiral and annular vessels inside; several strata of slightly thickened libriform surround the vessels, forming an almost continuous band inside the cambium. The thin-walled pith is solid, and many of its cells contain the brown substance mentioned above. Viewed in longitudinal sections, the cells of the cortex containing this substance are often placed on top of each other as long, continuous rows, while those of the pith are much longer than the surrounding parenchyma, thus representing ducts, but with no epithelium.

The subterranean part of the same stem has a thin-walled epidermis, and the cortex is composed of about fifteen strata with numerous cells containing the brown substance, especially in those which border on the endodermis. Endodermis has become a phellogen, having developed several strata of thin-walled cork. The stereome is present as isolated, arch-shaped strands. The mestome contains more leptome and hadrome than in the aerial internodes, besides that the interfascicular cambium has given rise to secondary mestome-strands with

libriform, the walls of which are thick and gelatinous.

While the internodes of the seedling show the same structure as the aerial stems described above, the basal, swollen part of the epicotyl has a broader cortex of about eight strata with no deposits of starch, and with only a very few cells containing the dark-colored substance, moreover the stereome forms small, isolated strands, separated from the endodermis by a continuous layer of thin-walled parenchyma. There is also present a single stratum of endodermal cork.

The increase in thickness of the vine is thus confined to the basal, subterranean portion, and depends merely upon some few layers of endodermal cork, and the development of small, secondary mestome-strands from the interfascicular cambium.

THE RHIZOME.

The parts of the rhizome examined are: lateral stolons developed from large tubers viz. the very young, slender ones, marked S in figure 2; the long, creeping one in figure 3, which is beginning to form tubers; and finally, the long, tuberiferous one in figure 2, which terminates into an aerial shoot (St.). The youngest of these (S, fig. 2) shows the structure as follows. It is cylindric and glabrous, with a corresponding, cylindric stele (in cross-section) of sixteen collateral mestome-strands. The epidermis is thin-walled, and the cortex (C.) consists of about ten compact layers without starch and with only a very few cells containing the dark-colored substance. The endodermis is thin-walled, and shows the Casparyan spots very plainly, and has already begun to develop cork (figure 10.) Inside the endodermis is a single, continuous stratum of thin-walled parenchyma (P in fig. 10) surrounding a band of isolated strands of thin-walled stereome (St., figure 10.) The mestome-strands (figure 10) contain a wide duct in the leptome (D), a few layers of cambium, and a few spiral vessels. The broad pith contains no starch, but many of the cells are filled with the dark-colored substance. At the very base of this same stolon the cortical parenchyma shows numerous cells close to the endodermis filled with the dark substance. The only sign of a beginning of increase in the thickness is

indicated by the endodermis becoming a phellogen. It deserves notice that the thin-walled parenchyma which was first observed inside the endodermis in the swollen epicotyl, recurs in the young stolon. Furthermore, there is a small, very delicate tissue, "endoxyle," on the innermost flank of the hadrome, the further development of which will be described later.

In passing to describe the structure of the long, creeping stolon (figure 3), we might begin with the internode, marked A; the stolon is about three months old, and shows secondary growth very plainly. At this particular point, by A, the stolon is much thicker than those described above, (figure 2, S.) And the thickness is due to the many strata of cork, which have been developed from the endodermis, as heretofore push off the epidermis and the greater part of the cortical parenchyma, except the innermost two or three strata, which still persist and of which many cells show the dark-colored substance. There are twelve collateral mestome-strands with one to two ducts in the leptome, and with two to three porous vessels of considerable width. The broad pith is solid, but only a few of its cells contain the dark substance, mostly of a purplish color. The strands of stereome are small, isolated. The thin-walled parenchyma between these and the endodermis is very distinct. Secondary thickening is shown also by the mestome-strands, in which the cambium forms a zone of great width, and passing into a similarly highly developed inter-fascicular. The endoxyle mentioned above is still very little in evidence.

This same stolon, examined at the point marked B, which is just behind the very young, tuberous swelling, shows about the same structure. The cortex, however, is better preserved, and the epidermis has not been thrown off entirely. Cells with the dark-colored substance are rather numerous outside the endodermis, but there are very few in the pith. The cork is present only as a single stratum. The stereome represents an almost closed sheath inside the thin-walled parenchyma. The mestome-strands are smaller than in the former section. In other words the structure shows plainly, that the portion of the stolon is somewhat younger than the one at the point marked A.

While the parts examined (A and B) are from slender internodes, the part marked C is a young tuber, just beginning to be formed. Secondary roots have developed, and they are endogeneous. The stele is not circular in cross-sections, but approximately triangular or, in some places, quadrangular. The epidermis and the greater part of the cortex have been thrown off, but the cortex was composed of eight strata, and many cells outside the endodermis contained the dark-colored substance. Four layers of cork have been developed from the endodermis. The thin-walled parenchyma between the endodermis and the stereome is very distinct. The stereome is present as separate arches covering the broad leptome, in which the primary duct is still evident, besides one or two secondary ducts in the innermost part of the leptome. The hadrome contains about four vessels in two rays, with some few strata of libriform. The endoxyle is well represented showing many cell-divisions (Fig. 14.) The cambium occurs as intra- and interfascicular, the latter giving rise to small strands of leptome with a duct, but no hadrome, and no libriform were observed between the primary mestome-strands. The pith is rather narrow, solid and contains starch, but only a few of its cells contain the dark-colored substance.

Having thus described the structure of the young rhizome from the short, slender stolons to the long, creeping with the first appearance of the tubers, we will now pass to examine the mature rhizome, the slender and the tuberous internodes. Of these the slender portion represents, as stated above, only a part of an internode, since it actually extends to the swollen base of the tuber in front of it. And characteristic of this slender portion is the constant absence of roots, leaves, and lateral shoots, subterranean as well as aerial. The epidermis and primary cortex have become replaced by about eight strata of homogeneous, thin-walled cork, inside of which the thin-walled, parenchymatic stratum is still intact, and shows no cell-divisions. The stele shows a considerable increase in thickness of the mestome-strands, notably in the leptome, which contains now two concentric bands of ducts, the secondary being several together and of great width. Stereids occur as small, isolated strands outside the leptome, as well as scat-

tered within the leptome itself. The secondary hadrome shows several porous vessels of considerable width, partly surrounded by small strands of libriform with gelatinous cell-walls, and accompanied by long, narrow cells with small, rhombic crystals of calcium oxalate. Inside the primary, narrow vessels we observe the endoxyle forming a very delicate tissue with indications of tangential cell-divisions. Between the twelve mestome-strands, all making up a single, circular band (in cross-sections) we observe strata of thin-walled parenchyma forming very narrow rays between the hadrome parts, but extending considerably in width between the leptome-strands, and this parenchyma owes its existence to the interfascicular cambium, some few elements of which are still present, here and there. No secondary leptome nor ducts were observed in the periphery of this interfascicular tissue, or, let us say, of these medullary or parenchymatic rays. In the center of the stele is a narrow pith, compressed and linear (in cross-section), containing a little starch, and some few (12) cells are filled with the dark-colored substance.

Regarding the tuber, the structure has now attained its almost final development as to increase in thickness. The cork consists of numerous strata; the parenchymatic sheath has remained intact, as a single stratum with the cell-walls of exactly the same structure as before. The stereome shows the same position as before, corresponding with the collateral mestome-strands, which are now somewhat farther apart, but still represent a single band. The leptome contains two concentric bands of ducts, the inner one with several ducts situated close together and of great width. The hadromatic rays are deep, but narrow as compared with the leptome, and small scattered strands of libriform are much in evidence. Cambium is still present as intra- as well as inter-fascicular, and the medullary rays are quite broad. On the inner flank of the hadrome we find the endoxyle extending deeply into the pith as a narrow, radial ray (Fig. 13.) The pith occupies the greater part of the whole section, and contains large deposits of starch, but only a few cells contain the dark colored substance.

So far, we readily recognize the principal features of the

structure in the tuber, which were described as being characteristic of the rhizome in its younger stages. However a very essential structure is yet to be noted, one which is peculiar to the tubers alone. This structure depends on the presence of numerous small mestome-strands, which traverse the pith in various directions and which are especially noticeable in longitudinal sections. These mestome-strands contain always a wide duct with the epithelium of same structure as that of the ducts in the primary and secondary leptome; also some few stereids accompanied by cells with crystals of calcium-oxalate; a little leptome; and a few, very wide, porous vessels. The origin of these thin mestome-strands may be sought, at least to some extent, in the activity of the endoxyle, for several of the sections showed very plainly that the endoxyle had advanced so far in its further development that cambial strata, and some few elements of hadrome were differentiated. The endoxyle has been observed in many plants of the various natural families, and Russow is evidently the first author, who called attention to its existence. But it has been interpreted in different manners, for instance by Vesque as "liber mou rudimentaire," and Raimann, who called it "intraxyläre Cambiform" held the same opinion, considering it to represent a reduced, internal leptome. On the other hand, Solereder and Juel have referred this tissue to the hadrome. And whenever it occurs, the endoxyle is almost as a rule an inactive tissue which in Apios, however, stays dormant for some time only, attaining some activity at an advanced stage and to become the mother-tissue of new mestome.

With regard to the increase in thickness as exemplified by the tuber, this is effected by the secondary growth of the mestome, notably the leptome; by the pith, and to some extent also, by the advanced development of the endoxyle.

THE PEDUNCLE OF THE INFLORESCENCE.

When the flowers are beginning to open, the peduncle is cylindric with a corresponding cylindric stele (in cross-sections), and with a relatively narrow, solid pith. The cuticle is thin and smooth, and the outer cell-wall of epidermis is slightly thickened. Scattered unicellular, pointed hairs occur, but

they are generally much shorter than those upon the leaves. The cortex consists of three compact layers of roundish cells, containing chlorophyll, but no colored substance like that observed in the stem. There is a distinct endodermis, containing a little starch, and inside this is a continuous sheath of thin-walled stereids in about three strata. The thin-walled sheath of parenchyma, which in the basal portion of the epicotyl and in the rhizome is developed between the endodermis and the stereome is absent. The mestome-strands form a broad zone, containing large groups of leptome, each with a very wide duct, but with no stereids interspersed. The hadrome shows several wide, porous vessels, and some narrow, spiral ones inside; thick-walled parenchyma, the cells radially arranged, surrounds the vessels. The medullary rays are very narrow. The pith contains starch, and some of its cells are filled with the dark-brown substance.

We have mentioned the presence of a thin-walled parenchymatic sheath between the endodermis and the more or less continuous band of stereids in the subterranean part of the epicotyl and in all the internodes, slender as well as tuberous, of the rhizome. This sheath consists of a single stratum, and was never observed to develop any further, and we regret to admit, that we can not explain its function. And as may be seen from the preceding pages we have avoided using the term "péricycle" for this particular sheath as well as for the stereomatic. Some authors would undoubtedly refer both sheaths to a pericycle in the sense of Van Tieghem. A brief abstract of the history of the term "pericycle" may be appropriate at this place. Van Tieghem, who proposed the term, applied it to a parenchyma of one or several layers, which he observed in the stem between the endodermis and the mestome-strands, as well as in the roots between the endodermis and the outer face of the leptome, and between the endodermis and the proto-hadrome vessels. To the activity of the pericycle Van Tieghem ascribed the origin of the interfascicular arches of cambium with the subsequent development of secondary mestome-strands. Morot describing the pericycle in general, calls attention to the fact that while the pericycle is always present in roots (frequently called pericambium), it is not

always to be found in stems. He agrees with Van Tieghem, however as to the function of the pericycle. Gérard and Hérail question the assertion of Van Tieghem regarding the function of the pericycle in stem, and describe a number of cases, where interfascicular tissues develop independently of the pericycle. Moreover, Hérail describes some cases of secondary mestome being developed in the pith (*Melastomaceae* and *Campanulaceae*.) Finally Haberlandt makes no use of the term pericycle in stems, but only in roots; and in reference to the secondary increase in stems, this author speaks of a "cambium ring" being the direct product of a "procambium," and of an interfascicular cambium owing its existence to a meristem in the primary parenchymatic (medullary) rays. According to our observations we have never felt induced to consider the pericambium in roots and the so-called pericycle in stems as homologous tissues; as a matter of fact we have frequently observed the same conditions as those cited by Gérard and Hérail. And with regard to *Apios* neither the parenchymatic nor the stereomatic sheath correspond with a pericycle in the stricter sense of the word.

THE LEAF.

The petiole examined at the characteristic point, just beneath the lowest pair of leaflets, is almost cylindric with two narrow wings on the ventral face. The cuticle is smooth and thin; the outer cell-wall of epidermis is quite thick. The cortex consists of three compact layers with chlorophyll. There is no endodermis, but a continuous sheath of two to three layers of thick-walled stereome surrounds the main stele of several mestome-strands, in which the very broad leptome contains two to three wide ducts; between the mestome-strands are broad rays of thin-walled parenchyma. A single mestome-strand is located in each of the two wings, and surrounded by sterome. The pith in the main stele is hollow, and some few cells in the periphery contain the dark-brown substance.

THE LEAF-BLADE.

The structure is bifacial. Viewed in superficial sections the epidermis of the ventral face has the lateral walls strongly

undulate, but stomata are absent. Unicellular, pointed hairs follow the veins; and above the veins the epidermis consists of long, rectangular cells, each with a large, rhombic crystal of calcium oxalate. The dorsal epidermis shows the same structure, but stomata are present, and they are surrounded very regularly either by two or by four ordinary epidermis-cells. The pneumatic tissue shows very wide inter-cellular spaces, the cells being of an almost stellate shape. In transverse sections the epidermis is thin-walled, and the lumen wider on the ventral than on the dorsal face. The chlorenchyma consists of a single layer of high palisades covering three open strata of pneumatic tissue. The midrib contains some water-storage tissue on both faces and is also supported by an arch of stereome outside the leptome; the palisade tissue extends to the sides of the ventral group of water-storage-tissue, while no green parenchyma is located in the dorsal keel, formed by the midrib. Regarding the midrib itself, this consists of four separate mestome-strands, each with one or two ducts in the leptome; but in no part of the leaf-blade did we observe any cells containing the dark colored substance.

The structure of *Apios* thus shows several points of interest, for instance the abundant presence of stereome, as stereome s. s. as well as libriform in all parts of the stem, and accompanying the mestome in the leaves. We have also seen the never failing presence of the wide ducts with epithelium in the leptome, wherever this is represented, but in the leptome alone. The peculiar dark brown or purple content, by various authors described as tannin, does not consist of this matter, so far as we could observe; we found, as a matter of fact, no trace of tannin in any part of the plant. The distribution of these cells, containing this matter, varies somewhat in accordance with the parts examined. They are very numerous in the cortex of the aerial internodes, as well as in the pith; in the young stolons (S) there are only a few in the cortex, but many in the pith, while in the creeping, somewhat older stolons they are quite numerous in the cortex, but scantily represented in the pith; in the tuber they are abundant in the cortex, especially close to the endodermis, while the pith contains only a

very few. They recur in the pith only of the floral peduncle and in the petiole.

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EXPLANATION OF FIGURES.

APIOS TUBEROSA.

Figure 1. The seedling, natural size.

Figure 2. The rhizome; St.—base of aerial stem; S—two stolons; R—roots; two thirds of the natural size.

Figure 3. Another rhizome, showing the beginning formation of tubers upon the long, creeping stolon; the letters A, B, C indicate the places examined and described in the text; two thirds of the natural size.

Figure 4. A young tuber from the stolon in figure 3; enlarged.

Figure 5. Apex of a young stolon (S. in figure 2); enlarged.

Figure 6. The young tuber at C, upon the stolon in figure 3; enlarged.

Figure 7. Epidermis of lower face of leaf; x 360.

Figure 8. Cross-section of one of the secondary roots, marked R in figure 2; C—cortex; End.—endodermis; P—pericambium; St.—libriform; D—duct; x 480.

Figure 9. Cross-section of an aerial internode, showing the vessels and the endoxyle; x 480.

Figure 10. Cross-section of base of a young stolon; letters as above; x 480.

Figure 11. Longitudinal section of an aerial internode, showing the dark cell-content in cortex (C.) and endodermis (End.); x 360.

Figure 12. Cross-section of a mestome-strand from young stolon, (S in fig. 2) showing the duct (D) in the leptome, the cambium, and the hadrome; x 480.

Figure 13. Cross-section of a mature tuber, showing the inner part of the hadrome with libriform (St.), and the endoxyle; x 480.

Figure 14. Cross-section of the very young tuber (C. in figure 3), showing the innermost vessels, the libriform, and the endoxyle with cambial strata; x 600.

A New Helianthus From Kentucky.

FRANK T. McFARLAND AND W. A. ANDERSON, JR.

Kentucky, because of her geographical location and her geological formations, offer to the present day botanist an excellent opportunity for the study of the plant distribution and the probable geographical extension of many species not now credited by the Seventh Edition of Gray's Manual.

Since 1912 the senior author has been studying the range of the phanerogams and pteridophytes of the state. Most of the state has been covered with the exception of two localities, one being in the extreme Northeastern part of the state south of Ashland, and the other in the southern part of the state just south of Somerset and to the Tennessee border. These two regions have never been visited by a botanist so far as the writers are aware. No doubt these two regions, which represent virgin conditions, when worked over, will yield many new and interesting things.

During August and the early part of September 1923, the writers in company with two assistants, J. B. Taylor and S. L. Dorsey, spent their time in working over that part of the state lying west of the Tennessee River which is generally known as the Purchase Region. From the first, it was the intention of the party to make an ecological survey of these eight counties, but finding the territory too large to cover in the time available, plans were modified so that all the time was taken in making collections of plants.

Wickliffe, on the banks of the Mississippi River was chosen for the first station, largely because of the extensive sloughs and cypress swamps. This region proved to be very interesting and many plants not reported for the state were found. After spending ten days at this station, camp was moved to Clinton, Ky., a beautiful little town, thirty miles south and about twelve miles from the Mississippi. This region being higher and drier proved to have less of the malarial mosquito, which was very abundant and troublesome at Wickliffe. The

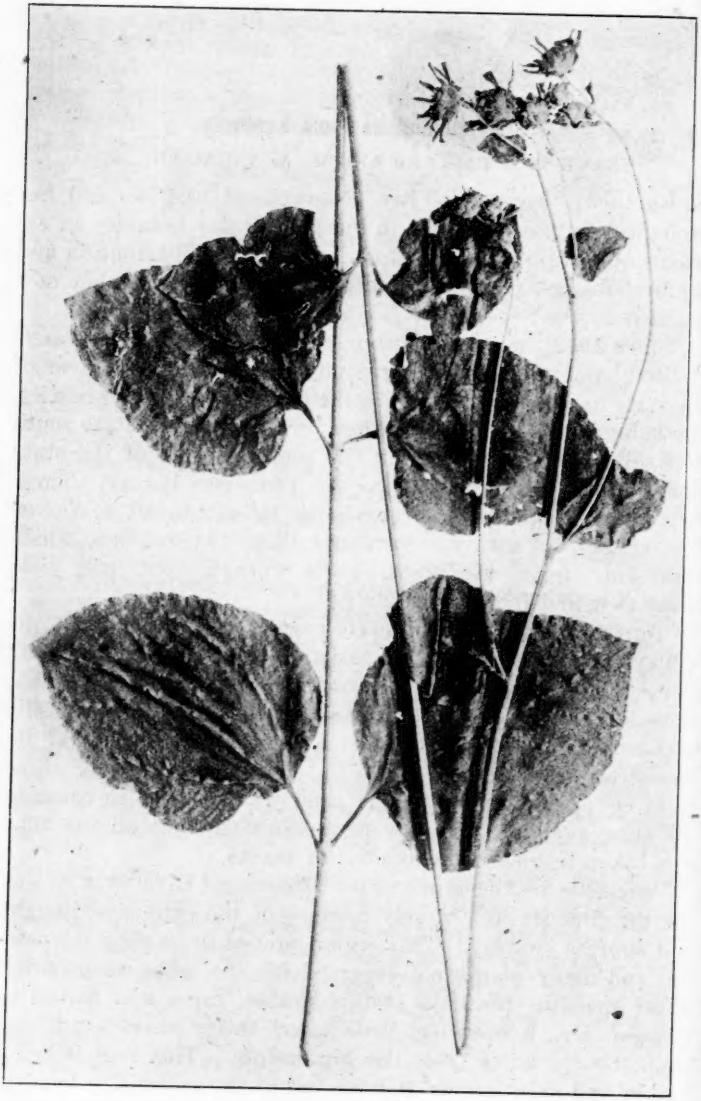

PLATE X.

country about Clinton was quite thoroughly covered by automobile and here many heretofore unreported species were collected.

East of Clinton, the land is gently rolling while to the west, the land is more rugged. Owing to the greater diversity of the topography of this region west of Clinton, we found collecting very good. On the 24th of August, while on our way to Columbus, one of the party discovered by the roadside a plant which at first was taken for a Silphium. Specimens were collected and taken to the laboratory and on investigation, proved to be a true Helianthus. After spending much time in trying to locate it in the various manuals and without success, specimens were sent to Mr. E. E. Watson, Michigan Agricultural College, East Lansing, Mich., Mr. Watson acknowledged the receipt of the specimens and in his reply, said that the specimens were different from any that he had worked over, and that the plant was apparently an undescribed species. This was the same conclusion that the writers had come to before submitting the plants to Mr. Watson. We feel that this plant is so strikingly different from any of our described species that we feel justified in reporting this plant as a new species.

This sunflower which we propose to name *Helianthus kentuckiensis*, The Kentucky Sunflower, was found growing on a sandy clay bank along the roadside, six miles west of Clinton, on the Clinton-Columbus road. The black, knotty, woody roots as well as the very strigose stems and leaves will serve readily to identify it in the field. (See Plate No. X.)

Helianthus kentuckiensis, n. s.

Planta perennis cum ligneis nodosisque rhizomatibus; caulis strigosissimus sparse ramatis supra, 1.6-2.3 m. altus: foliis firmissimis, crassis, denticulato-crenulatis, ovatis-deltoideis, triplinervatis, duabus faciebus scabrosissimis, truncatis pilis ad basim glandulosis, 10-12 cm. longis, 7.5-10 cm. latis, infimis oppositis, superis alternis et minoribus: petiolis anguste alatis, 2-3 cm. longis; capitulis paucis 2-4, ramos terminautibus,

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* Contribution No. 7, Department of Botany, University of Kentucky.

prope 3.5 cm. latis. Involucrum hemisphericum, bracteis imbricatis 3 vel 4 in seriebus, obtusis, mucronatis ciliatis scabrosis; pilis tenuibus ciliatis; disco conico crebro. Floribus discoideis, fulvo-purpurascentibus, radiis 12-14, flavis et acutis; achensiis quadrangulatis, pilosis, circulo cum brevibus ciliis in summitate. Pappus duobus brevibus tenuibusque paleis, indutus margine ciliato, 2 mm. longa.

Habitat in solo arido siliceoque per viam ex occasu venienti sex milia passum ab urbe Clintonensi, Ky., in via Columbana.

Floret mense Augusto et Septembri. Nota est ex solo loco suo. Exemplar in Herbario McFarlando, No. 374. Exemplaria similia adsunt.

In Herbario Nationali, Washington, D. C.

In Herbario Universitatis Kentuckiensis, Lexington, Ky.

In Herbario Universitatis Harvardensis, Cambridge, Mass.

In Herbario Missouri Botanici Horti, St. Louis, Mo.

In Herbario Universitatis Nostrae Dominae, Notre Dame, Ind.

DESCRIPTION:

Helianthus kentuckiensis new species

The Kentucky Sunflower.

Perennial by woody, black, knotty rootstocks; stems sparingly branched above, very strigose, 1.6-2.3 m. high. Leaves very firm, thick, denticulate-crenulate, ovate-deltoid, the acute base truncate to slightly cordate, triple nerved, very scabrous on both sides, each hair rising from a glandular base; 10-12 cm. long, 7.5-10 cm. wide, the lower opposite, the upper alternate and more or less reduced in size; petiole narrow winged, 2-3 cm. long; heads few, 2-4 at end of each branch, approximate, 3.5 cm. broad; involucre hemispherical, bracts imbricated in 3 or 4 rows, obtuse, mucronate, ciliate and scabrous; chaff thin, ciliate; disk low conic; disk flowers purplish brown, rays 12-14, chrome-yellow, showy, pointed; achenes quadrangular, somewhat hairy on the faces with circle of short hairs at the crown; pappus consisting of two short thin awns, ciliate on margin, 2 mm. long.

Habitat: In dry sandy clay soil along roadside six miles west of Clinton, Ky., on the Columbus road.

Season: Late August and September.

Known only from type locality.

Type in McFarland Herbarium No. 374.

Co-types are deposited in:

Herbarium National Herbarium, Washington, D. C.

Herbarium Missouri Botanical Garden, Saint Louis, Mo.

Herbarium University of Kentucky, Lexington, Ky.

Herbarium Harvard University, Cambridge, Mass.

Herbarium University of Notre Dame, Notre Dame, Ind.

University of Kentucky.

BOOK REVIEWS

In this section are reviews of new, or particularly important and interesting books in the fields of natural science. Books dealing with botany or kindred subjects should be sent to the Editor, the University of Notre Dame. *All other books for review* should be sent to Carroll Lane Fenton, at the Walker Museum, the University of Chicago, Ill. Publishers are requested to furnish prices with books.

THE OUTLINE OF SCIENCE, edited by *J. Arthur Thompson.* American edition, in four volumes, published by G. P. Putnam's Sons. $4.50 per volume.

The most astonishing thing about this set of books is the fact that a publisher had sufficient confidence in the general educated public to undertake the task of getting out "The Outline of Science." For the deslike of the educated public for anything that might educate it more is so old as to be proverbial, and no publisher can flourish on dislikes for the things which he publishes. But evidently things with the public are not so bad as they used to be. Wells' badly conceived "Outline of History" has long since passed the quarter million mark, and Van Loon's infinitely better "Story of Mankind" is in its 110th thousand. I do not know the sale of Thompson's "Outline" but Mr. Putnam seems to be pleased.

The first volume appropriately enough, begins with a survey of the universe in general, and our solar system in particular. The author is very uncertain as to how the solar system developed; he appears to favor the Planetesimal hypothesis, but I suspect that, like most Englishmen, he is unable to break away from the gaseous ball of Laplace. Evidently there is need for some popular book that will, once and for all, disabuse the popular mind of Laplaceism, for until that is done there can be no clear thinking on either geology or zoology. It is a pity that Dr. Thomson did not attend to the job.

The chapters on the history of the earth, and the development of life are clear and interesting, as is also the section of "Adaptations to Environment." "The Struggle for Existence," too, comes in for a treatment quite proportionate to the position it holds in general interest. The chapter dealing with the ascent of man is less satisfactory; one gets the impression that the writer was none too sure of himself, and was afraid that he might tell too much. Mr. Wells has done much better. But the section on the "Foundations of the Universe," which deals with everything from theories of electrons to wave action, suffers from neither haziness nor undue abbreviation. Perhaps I got a special pleasure from it because of my general ignorance regarding chemistry and physics. But I am quite sure that my ignorance is not greater than that

of most folks who will read the book, so my liking for the chapter is sustained.

The most striking portion of the second volume is the three chapters devoted to natural history,—birds, mammals, and insects. They are admirably written and better illustrated; they tell what is important to know, and omit the abundant anecdote that used to clutter the pages of natural histories. Other chapters,—on botany and the lower vertebrates—are given in the third and fourth volumes, along with discussions of more fundamental or general topics, such as biology, characteristics of living creatures, and so on. It is hard to see the advantage of such a treatment, at least when one has been accustomed to the meticulous order of Parker and Haswell and of Hertwig. I should like to see a more compact arrangement of the natural history material—indeed, I should like to see it put into one volume, with all the necessary pictures, and issued separately. The old time natural history made famous and also infamous by the Reverend Wood, appears to be thoroughly dead. It has disappeared from the book shelves in schools, and from the counters in stores, and the pages of the mail-order catalogue. And so far there has been nothing to take its place. Mr. Duncan's big volume, published in England by Cassell and in America by Funk & Wagnalls is too nearly a zoology to please or interest the average youngster. He looks at its pictures, but he does not read its too systematic and informing pages. But the natural history sections of the Outline he would both look at and read, but to own all of them, he or his father must spend $13.50. And there are many youngsters, and many schools and libraries, to whom the spending of $13.50 is an almost unheard-of thing. $4.50 they could manage, but three times that sum is too much.

But it is not the function of a reviewer to give financial advice to publishers who are so kind as to send him books; they are capable of attending to that themselves. Yet when a reviewer honestly likes a book, honestly thinks that anyone between the fifth grade and a Ph. D., can learn many things from it, he may be justified in allowing his enthusiasms to run free. For I feel just that way about the "Outline of Science"; that it is a valuable work for the library, the youngster, the professional or business man, and the scientist. Of course, there are some things about it I do not like, but there are many more that I do. I might complain because there is a chapter on psychic "science" by Sir Oliver Lodge, and opine that Mrs. Eddy, Pastor Russell, and W. G. Voliva should have their share too. Yet Mr. Lodge's chapter is interesting, and the person who has brains enough to read the 564 pages that precede it will not be seriously damaged by Mr. Lodge on telepathy and clairvoyance. I might complain loudly about the treatment of the origin of the earth, but I find it more to the point to praise such chapters as the "Story of the Rocks", the "Romance of Chemistry", and so on. For every unsatisfactory thing about the books there are

hundreds of features of astonishing goodness. For every bad picture there are fifty very, very good ones, and even the worst are far better than the average in other books. I do not, of course, agree with the London Morning Post when it proclaims the "Outline to be so accurate that the expert cannot cavil at it, so simple that the general reader, who has no time for special study, can understand it." Experts can and will cavil at any book, excepting perhaps the one they write themselves, and no book so big and so all-inclusive as this can hope to be perfect. But Dr. Thomson's comes surprisingly close to the mark, and stands as far and away the best popularization of science in print.

C. L. F.

NATURE MAGAZINE, edited by *P. S. Risdale* and *A. N. Pack*. Monthly, published at 1214 Sixteenth Street, Washington, D. C. $2.00.

The first number of this excellent magazine appeared in the middle of January, and the second appeared promptly a month later. It is published by the American Nature Association, which appears to be sustained largely by the magazine. Subscription carries with it membership in the association. Aside from the magazine, the principal advantage derived from membership appears to be the opportunity to participate in the organization's book-buying service. This service procures for members any book on natural science in print, sends it postpaid, and allows a discount of ten percent. If one buys many books, that discount is apt to be important.

The magazine itself is strictly popular—somewhat on the order of the old "Birds and Nature", long since defunct. The articles are short, the longest in the February issue taking up less than five pages. There are abundant pictures, admirably printed. The editors appear to be specially anxious to secure justice for snakes, and have several very good snake photographs. All in all, the "Nature Magazine" appears to be a highly worth while publication, that deserves a wide circulation among town and school libraries, and in homes where there are children to be interested in wild things.—C. L. F.

MAN'S PREHISTORIC PAST, BY HARRIS HAWTHORNE WILDER. The Macmillan Co.

ANCIENT MAN IN BRITAIN, BY DONALD A. MACKENZIE. Frederick A. Stokes Co.

Had Professor Wilder succumbed to the recent craze for "Outlines" he probably would have titled his book "The Outline of Prehistory." But this professor of zoology who is able to make even comparative anatomy interesting has too much individuality to fall under the spell of fads, and it must be admitted that he has done excellently.

For "Man's Prehistoric Past" is more than an outline: it is a simple but astonishingly complete elementary treatise. From the first chapter on "The Chronology of Prehistory" to the last, dealing with "Known Types of Prehistoric Man" the book is neither hasty nor unbalanced—

both traits which we have come to expect in "Outlines." Nor are there many obvious errors; in fact, for the reader who is not a specialist in anthropology to point out a single one would be difficult. On points of theory, of course, there is no such infallibility; Professor Wilder follows Keith rather than Osborn, so that the older styles of archeologists will not always agree. But then, complete agreement is very apt to be the death of theory....

But perhaps it is unfair to pass judgment—even favorable judgment—on a book without first telling its scope. The first chapter, as I have intimated, gives a general survey of the time elements involved in the study, and the manner in which they are worked out. This is a field that often puzzles the educated layman: how do archeologists *know* that one race lived before some other, when they inhabited some quite distinct portion of the globe? Dr. Wilder answers such questions with a thoroughness that should satisfy even such men as Professor Price, who would have dinosaurs, trilobites, and coal-measure amphibians all romping about the earth at one time.

The chapter on "Materials and Methods" is to some extent an elaboration of the one on chronology, and is by all odds the clearest statement of the archeologic mode of operations that I know. There is nothing startling and new in it, of course; new things do not often get into elementary books, since they are very apt to be out of place. The same applies to the chapters on prehistory, which cover all of the continents except Antarctica, where prehistory is unknown. Perhaps the most imposing of them is the one on North and South America, continents which usually are slighted in discussions of ancient man. Writers seem to think that because the Aztecs were by no means so ancient as the Cro-Magnards they were far less important and interesting—a conclusion that is gravely to be questioned. The significance of a relic does not always depend upon its age, and it is quite possible that the genetic sociologist will learn more from the American Indians than he will from the bones of Mas d' Azil. And it is by no means the least significant thing about Dr. Wilder that he considers the needs of the genetic sociologist....

* * *

The reader will find the same breadth of view and interest in Mr. Mackenzie's study, "Ancient Man in Britain." The book "deals with the history of man in Britain from the Ice Age till the Roman period. The evidence is gleaned from the various sciences which are usually studied apart, including geology, archeology, philology, ethnology or anthropology, etc., and the writer has set himself to tell the story of ancient man in a manner which will interest a wider circle of readers than is usually reached by purely technical books."

A promising introduction, and in the main it is borne out in the body of the book. Of course it bears the stamp of Mr. Mackenzie's particular interest, which happens to be mythology, and it readily becomes evident that he is trying to interest those of us who prefer the geological or

purely archeological aspects of ancient man and care little for his mythology. The process is simple: Mr. Mackenzie merely demonstrates that by linking mythology, philology, geology, and archeology together one gets a full and remarkably reliable picture of the daily life of ancient man, while otherwise he gets but a partial representation.

The actual structure of the book is disappointing. In more than one instance the author has lost sight of that cardinal principle of expository writing—the telling of what one is going to show and the showing of it, terminated by a brief statement of what has been shown. Nor does he retain uniformity in organization; the early chapters are based on chronology and the late ones on subject material. Thus the first chapter is entitled "Britons of the Stone Age;" the second "Earliest Traces of Modern Man;" the third, "The Age of the 'Red Man' of Wales"—all clearly in sequence. But when the popular reader, to whom Mr. Mackenzie makes a strong appeal, has passed through these chapters he comes upon others on such subjects as "The Lore of Charms," and "Ancient Pagan Deities." Unless he has a more thorough knowledge than is to be found in most general readers, he will have a good deal of trouble tying this information together. For, it must be remembered, (though it generally isn't), this non-technical reader is a man who earns his living in an office, a store, or a factory, or by teaching unity, coherence, and emphasis to college freshmen. And when he gets through with his day's work and is ready to read, he has no time to make elaborate preparations—or even simple ones. He does not have to be spoon-fed, but the path of his inquiry should be made smooth, and that is not done sufficiently well of "Ancient Man in Britain." Yet were I asked to recommend a better book on the subject .... well, I'm thinking that Mr. Mackenzie has surpassed his peers, if not himself.

—CARROLL LANE FENTON.

PIERRE CURIE, BY MARIE CURIE. The Macmillan Company. $2.25.

In this book we have a simple biography, to which is appended a simple autobiography, that covers the lives of two great scientists. One is reminded of Mme. Curie's response when the writing of such an account was urged upon her. "Oh, but it will not be much of a book.... it is such an uneventful, simple little story. I was born in Warsaw of a family of teachers. I married Pierre Curie and had two children. I have done my work in France."

Perhaps it is an uneventful story.... like the story of almost any other scientific existence. But that does not mean that it lacks pathos and heroism. For it is not easy and pleasant to do great work on small pay and with defective and even dangerous apparatus. Our dollar-worshipping magazines have published page after page of cheap sentimentalization over Marie Curie and her husband, toiling in a Paris shed in order that they might discover a new element of tremendous importance. We Americans have an endless appetite for such

whang-doodle, and it tickles our fancy to imagine the great scientist doing great things in a hovel. Probably the French feel a good deal the same ... or they wouldn't have left the Curies to labor in a shed. And then, after taking from this little woman and her dead husband knowledge that is priceless, we felt tremendously virtuous over the gift of a hundred thousand dollars worth of radium. Perhaps we should feel virtuous; France chose to invest its money in warfare against new governments, to make necessary more radium.

Thus it is that I do not read this story of Pierre Curie's life of investigation and teaching without resentment, though I hasten to admit that there is none in the book. For both of the Curies their work, their love, and their home sufficed. And that is the spirit of this book.

—C. L. F.

WESTERN BIRDS, BY HARRIET WILLIAMS MYERS. Second Edition. The Macmillan Co.

This second edition of Mrs. Myer's book does not differ greatly from the first, but such changes as are to be found are in the way of increased usefulness. She still is on rather strained terms with the English language, particularly in the matter of relative clauses. But amateur bird students seldom are meticulous in their selection of composition.

The text is highly pleasing. Handbooks like Mrs. Bailey's are too obviously intended for identification to make pleasant reading, and there is many a beginning ornithologist who finds Chapman dull. By combining necessary descriptive material with a readable account of habits, range, and abundance Mrs. Myers overcomes this difficulty, thus making her book one that will attract as well as instruct. The accounts are not quite so pleasing as those of Neltje Blanchan's "Bird Neighbors," but they are far from dull. The numerous photographs of birds on the nest are attractive, though it might have been well to supplement them with a series, either of photographs or of drawings, that would be useful in identification. It is in such pictures that one finds the enduring value of the none too reliable Reed Guides, and the addition of similar ones, even in black and white, would add greatly to the usefulness of "Western Birds." But even without them it is a book that every nature student west of the Rockies—and many east of them—will find of great help and interest.

—C. L. F.